§2. Development of Safety Active Sampler for Tritium Monitoring in a Fusion Test Facility

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As one of the tritium monitoring techniques, the tritium sampler to accumulate the extremely low level tritium within a given period is utilized as the tritium monitoring equipments to check in term of the regulation. On the other hands, the biological effects of tritium differ according to their chemical form. Thus, it is preferred to measure the tritium concentration with a different chemical form for tritium monitoring. This type of tritium sampler has to add a combustion gases such as hydrogen gas and methane gas to obtain enough analytical water samples for liquid scintillation counting, because atmospheric concentration levels of H_2 and CH_4 are very low, about 0.5 ppm and 1.7 ppm, respectively. In the radiation control area of a fusion test facility, however, the tritium sampler has to operate entirely unattended. Therefore the system is required enough safety against combustion gas. In this report, we developed the continuous safety tritium sampler, which add the water vapor instead of combustion gases, with reference to Kakiuchi et al[1]. The preliminary results of the actual stack air sampling are given.

The schematic diagram of the developed tritium sampler is shown in Fig.1. The sampler has two paths for continuously sampling, i.e., the operational path switches other path after a given period of time. Tritium in the chemical form of HTO in the sampled air is first collected in molecular sieves (3A type) packed column. Then, the tritium free water vapor is added by the evaporation of tritium free water in the sampled air. The tritium free water of about 20 -40 g is put in an acryl vial and set in the water cooling type column. The cooling water temperature is controlled from -10°C to 10°C. Then tritium in the chemical form of HT is converted into HTO in an oxidation furnace with a Pt metal honeycomb catalyst at 100°C. The HTO that is being formed is then collected together with tritium free water in molecular sieves. In the last process, tritium free water vapor is added by the evaporation of tritium free water in the sampled air again as the same manner of HT collection and then residual tritium in the chemical form of CH_3T is converted into HTO by a Pd particle type catalyst heated to about 350°C. The HTO is collected in together with tritium free water in molecular sieves. The HTO collected in molecular sieves is desorbed at a heating temperature of 400°C and is recovered by the cold trap of about 2 °C under an N_2 gas purge at a rate of 1 L/min for 3.5 h.

The tritium sampler system was installed in a machine room and connected the sampling line to the stack. The air sampling was made at maximum flow rate of few hundred cm^3/min for one or few weeks. The total amount of air collected was approximately 4–10 m^3. To measure the tritium activity, 65 ml of recovered water from the HTO collection column and 65 ml of liquid scintillator Ultima-Gold LLT were mixed in a 145 ml Teflon vial. Ten ml of recovered water from each of the HT or CH_3T collection columns were mixed with 10 ml of liquid scintillator in 20 ml Teflon vials. Background samples in 145 and 20 ml vials were prepared using tritium free water. After leaving these samples for a few days in a low background liquid scintillation counter LSC-LB5 (Hitachi-Aloka medical Co. Ltd.), the tritium activity was counted in totally 1500 minutes per sample. The detection limits for the atmospheric tritium concentration are abut 3-5 mBq/m^3.

Figure 2 shows the preliminary results of the tritium concentrations of different chemical forms and absolute humidity in the air. Both of HTO and HT could be detected. However, CH_3T was seldom detected under these collection conditions, because the collected air volume was low. The average concentrations of HTO, HT and CH_3T were 10.3 ± 3.9, 5.5 ± 1.7 and 1.8 ± 1.9 mBq/m^3, respectively. The levels of tritium concentration are same as the levels of the environmental tritium concentration at NIFS Toki site reported by Uda et al[2]. Thus, it is found that this tritium sampling system is operated properly and measured correctly. The operation of air sampling in the facility will be continued for the monitoring of background levels of tritium before the deuterium plasma experiments.

1). Kakiuchi, H., et al., *Autumn meeting of JAES*, (2007), F22, [in Japanese].
2). Uda, T., et al., Fusion Sci. Technol., **60**, (2011), 1244.

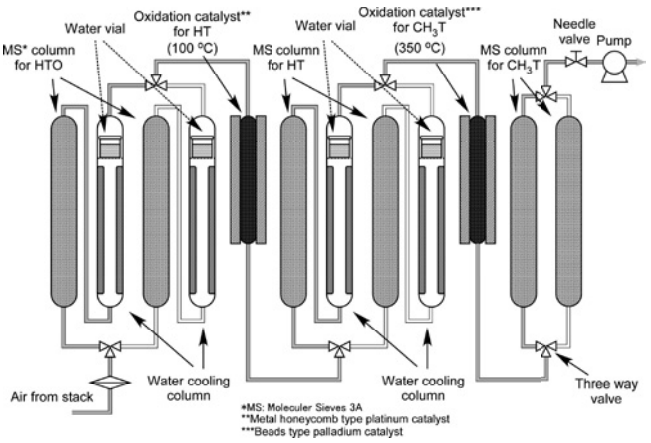

Fig. 1. Schematic diagram of safety active tritium sampler.

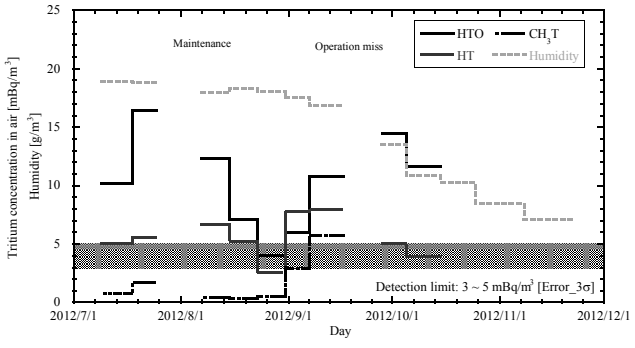

Fig. 2. Variation of tritium concentration of different chemical forms and absolute humidity in air collected by the sampler from 2012/7/9 to 2012/10/12